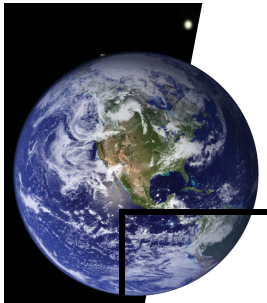
NASA Earth Science
Decadal Survey Mission Development Symposium

Washington, DC
February 11 - 12, 2009

Day 2 - Earth Science and the Decadal Survey Program

February 12, 2009

Day 2 Agenda



Day 2: February 12, 2009 Decadal Survey Program			
Time	Subject	Presenter	Duration
8:00	DS Program Implementation	Volz	60
9:00	Cross Mission Requirements	ESD	30
9:30	Cross Mission Assessments	ESMPO	45
10:15	Break		15
10:30	Cross Mission Synergy Discussion	All	60
11:30	Summary & Actions	ESD	30
12:00	Symposium Close		

- Day 2 Objectives:
  - *Define/Discuss ESD assumptions for implementation*
  - *Discuss programmatic framework for addressing cross mission issues*
  - *Define participatory approach for addressing issues - mission development team participation*
- Move Science coordination discussion to 9:30, to allow Jack Kaye to participate
- Schedule for follow through and next steps

Decadal Survey Implementation

Scientific & Programmatic Objectives

Science

To initiate the implementation of the Decadal Survey missions integral with the other elements of the overall Earth Science strategic plan.

To define the science requirements and conduct the mission definition in an open, transparent, and inclusive fashion

Programmatic

To define the mission definition and development to prepare for a range of possible funding scenarios

To define a unified program and project implementation approach that meets Agency requirements while being flexible, repeatable, and expeditious

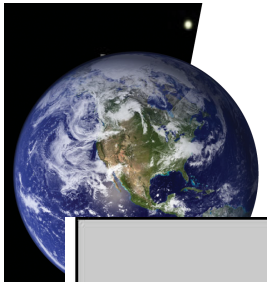
Science & Programmatic

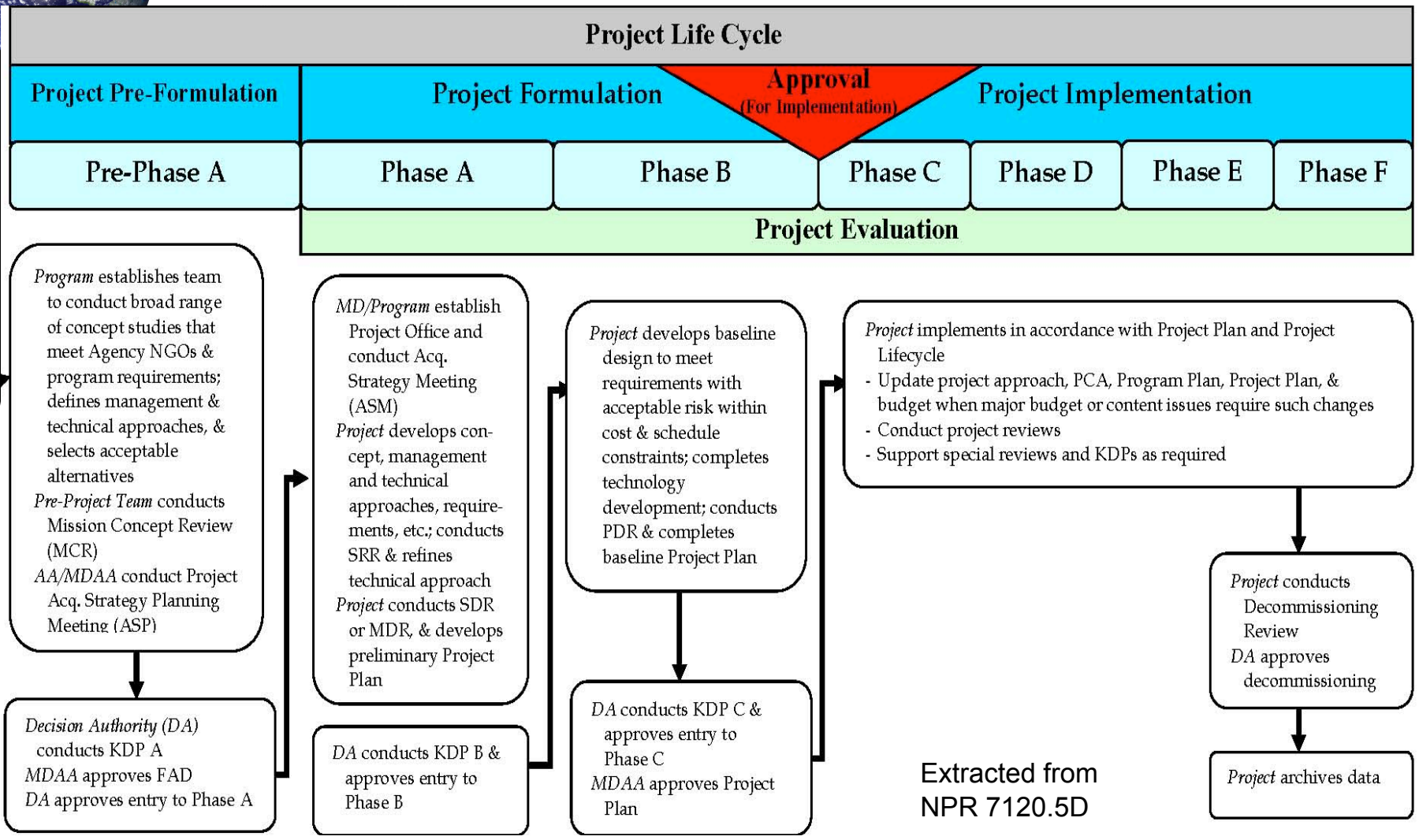
To develop sufficient supporting information on Tier I and Tier II missions and cross mission requirements to support a reasoned decision at the end of FY2009 on the path forward for funding and development of the missions

Mission Implementation

- NASA standard practices define the parameters for mission implementation
- The immediate focus on the best initiation of these missions
  - *Level 1 requirements & Formulation Authorization Document (FAD)*
  - *Mission classification*
  - *Launch Vehicle selection*
  - *Partnership identification and determination*
  - *Cost & Schedule assessment*

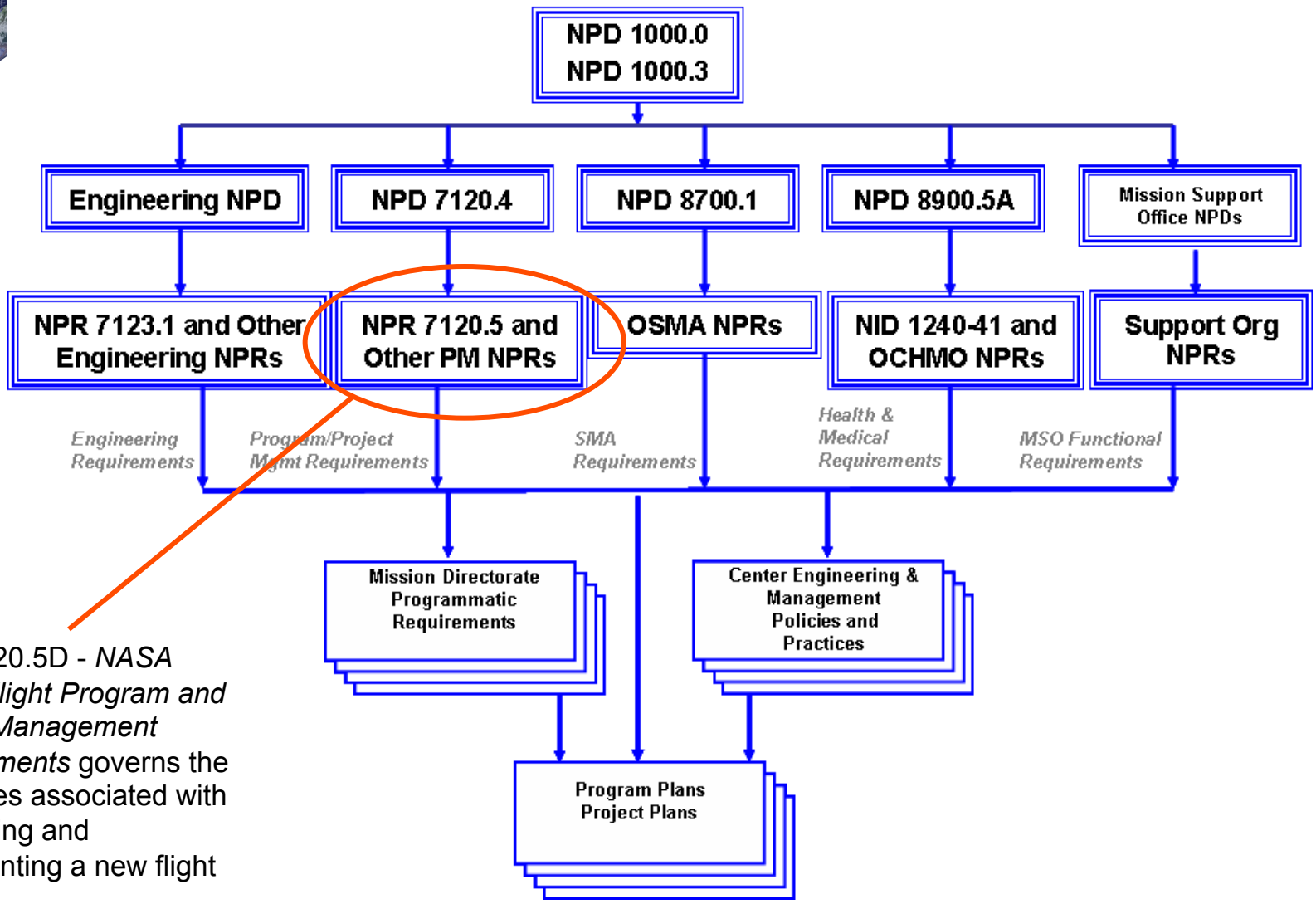
Flight Project Life Cycle





Extracted from NPR 7120.5D

NASA Hierarchy of Directives



NPR 7120.5D - *NASA Space Flight Program and Project Management Requirements* governs the processes associated with formulating and implementing a new flight project

Mission Requirements for Completing Pre-Phase A

To pass KDP-A and moved into Phase A the mission team must complete the following:

Headquarters Functions

- Approve a Formulation Authorization Document
- Develop DRAFT Level 1 Requirements
- Conduct Acquisition Strategy Planning Meeting

Technical Activities:

- Develop and document preliminary mission concepts
- Conduct internal Reviews
- Conduct Mission Concept Review Project Planning, Costing and Scheduling
- Develop and document a DRAFT Integrated Baseline, including:
  - *High level WBS*
  - *Assessment of Technology Readiness Levels*
  - *Assessment of Infrastructure and Workforce needs*
  - *Identification of potential partnerships*
  - *Identification of conceptual acquisition strategies for proposed major procurements*

Mission Requirements for Completing Phase A

To pass KDP-B and moved into Phase B the mission team must complete the following:

Headquarters Functions

- Establish SRB
- Establish Baseline Level 1 Requirements
- Conduct Acquisition Strategy Meeting
- Initiate Interagency and International Agreements
- Complete IPAO ICE and ISA

Technical Activities:

- Develop preliminary system level requirements
- Develop/document Baseline Mission Concept
- Develop preliminary mission operations concept
- Initiate technology developments
- Develop initial orbital debris assessment
- Conduct System Requirements Review
- Conduct Mission Definition Review

Project Planning, Costing and Scheduling

- Prepare a preliminary Project Plan
- Conduct required Integrated Baseline Reviews
- Develop/document preliminary Integrated Baseline
- Identify Export Controlled technical data

NPR 8705.4 Payload Risk Classification Rationale

Mission Classification

- Classification drives numerous elements of the mission implementation approach and is a significant driver in defining the cost and schedule of the mission
- Determines the governing Program Management Council (PMC) and through that the approach for authorization and modification to all baseline control documents
  - *Class A: Agency PMC*
  - *Class B & C: Directorate PMC*
- Centers also impose different criteria on mission development depending on the classification

- Classification is proposed during pre-Phase A, with assignment made no later than KDP-B

Mission Classification Criteria

	Class A	Class B	Class C	Class D
Priority (Criticality to Agency Strategic Plan) and Acceptable Risk Level	High priority, very low (minimized) risk	High priority, low risk	Medium priority, medium risk	Low priority, high risk
National Significance	Very high	High	Medium	Low-to-medium
Complexity	Very high to high	High to medium	Medium to low	Medium to low
Mission Lifetime (Primary Baseline Mission	Long >5yrs	Medium 2-5 yrs	Short	Short (<2 yrs)
Cost	High	HIgh to Medium	Medium to low	Low
Launch Constraints	Critical	Medium	Few	Few to None
In-flight Maintenance	N/A	Not feasible or difficult	May be feasible	May be feasible and planned
Alternative Research Opportunities or Re-flight Opportunities	No alternative or re-flight opportunities	Few or no alternative or re-flight opportunities	Some or few alternative or re-flight opportunities	Significant alternative or re-flight opportunities
Achievement of Mission Success Criteria	All practical measures are taken to achieve minimum risk to mission success. The highest assurance standards are used.	Stringent assurance standards with only minor compromises in application to maintain a low risk to mission success.	Medium risk of not achieving mission success may be acceptable. Reduced assurance standards are permitted.	Medium or significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.

Reference: NPR 8705.4, Appendix A *Classification Considerations for NASA Class A-D Payloads*

Recent Earth Science Mission Comparisons

	Risk Class	Program	Complexity [1]	Prime Mission Life	Phases A-D Cost (RY$)	LRD / Constraints	Non-NASA Partners
OCO	C	Earth System Science Pathfinder (ESSP)	Low	2 years	$252M	2009/None	None
Glory	C	Earth Systematic Missions (ESM)	Low	3 years	$287M[2]	2009/None	None
Aquarius	C	ESSP	Low	3 years	$236M	2010/None	CONAE: S/C, Mission Ops, Grnd Stations, instruments
SMAP	C	ESM	Low	3 years	$470M-$589M [3]	2013/None	TBD
ICESat II	B? C?	ESM	Low	3 years	$600M - $700M [4]	2014/None	TBD
OSTM	B	ESM	Low	3 years	$149M	2008/None	CNES: S/C, other instruments. NOAA: Ops, Grnd Stations
LDCM	B	ESM	Medium	5 years	$551M [2]	2011/None	USGS: Ops, Grnd Systems
GPM	B	ESM	Medium	3 years	$936M [2]	2013/None	JAXA: Instrument, LV
NPP	B	ESM	Medium	5 years	$729M [2]	2010/None	NPOESS IPO: Mgmt, Instruments, Ops. NOAA: Archiving

[1] Number of instruments, continuous or targeted observations, operational use, etc
[2] FY09 PPBE; direct costs only; do not include Center M&O, corporate G&A, or ODC
[3] Cost uncertainty due to launch vehicle

Example: SMAP Implementation

- The SMAP observatory is a single-string architecture, with enhancements applied to provide confidence in 3-year life within a Class C program
- Planned approaches to mitigate mission risk include:
  - *High heritage components, assemblies and subsystems wherever possible;*
  - *Graceful degradation design features (for the instrument, primarily);*
  - *Selective redundancy where analysis and/or experience dictates a benefit;*
  - *Grade 2 parts (min) for system elements that are not redundant/degrade gracefully;*
  - *Stress tests/off-nominal tests at appropriate level of integration as part of V&V plan.*
  - *Protoflight Test Program (not Qual/ATP)*
  - *EMs will be developed for new or significantly modified designs (few are anticipated)*
  - *Life test will be conducted for spin bearing and slip rings (and other limited life items)*
- SMAP mission parameters align most closely to a Class C Payload
  - *SMAP is comparable to other Class C Earth Science Missions*
  - *SMAP project will selectively implement enhancements beyond Class C requirements*
  - *3 Year Prime Mission duration is above typical Class C, but several Class C missions have 3 Year Prime Missions*

DS Mission Team Actions

ESD & ESM PO

- Develop a common definition for the classification criteria
  - *Primary Mission lifetime*
  - *Alternate Research or Re-Flight Opportunities*
  - *Achievement of Mission Success Criteria*
  - *Complexity*
- Issue as part of updated Earth Systematic Mission Program Plan

Mission Teams

- Develop an assessment of how the mission fits within these parameters
- Define mitigations or tailoring to classification, consistent with Center requirements
  - *Class C+ or Class B-*

Cost & Schedule Assessment

Mission Requirements for Completing Pre-Phase A

To pass KDP-A and moved into Phase A the mission team must complete the following:

Headquarters Functions

- Approve a Formulation Authorization Document
- Develop DRAFT Level 1 Requirements
- Conduct Acquisition Strategy Planning Meeting
- **Conduct initial cost & schedule assessment**

Technical Activities:

- Develop and document preliminary mission concepts
- Conduct internal Reviews
- Conduct Mission Concept Review Project Planning, Costing and Scheduling
- Develop and document a DRAFT Integrated Baseline, including:
  - *High level WBS*
  - *Assessment of Technology Readiness Levels*
  - *Assessment of Infrastructure and Workforce needs*
  - *Identification of potential partnerships*
  - *Identification of conceptual acquisition strategies for proposed major procurements*

Mission Requirements for Completing Phase A

To pass KDP-B and moved into Phase B the mission team must complete the following:

Headquarters Functions

- Establish SRB
- Establish Baseline Level 1 Requirements
- Conduct Acquisition Strategy Meeting
- Initiate Interagency and International Agreements
- **Complete IPAO ICE and ISA**

Technical Activities:

- Develop preliminary system level requirements
- Develop/document Baseline Mission Concept
- Develop preliminary mission operations concept
- Initiate technology developments
- Develop initial orbital debris assessment
- Conduct System Requirements Review
- Conduct Mission Definition Review

Project Planning, Costing and Scheduling

- Prepare a preliminary Project Plan
- Conduct required Integrated Baseline Reviews
- Develop/document preliminary Integrated Baseline
- Identify Export Controlled technical data

Mission Study Results More Closely Matched to Decadal Survey assumptions

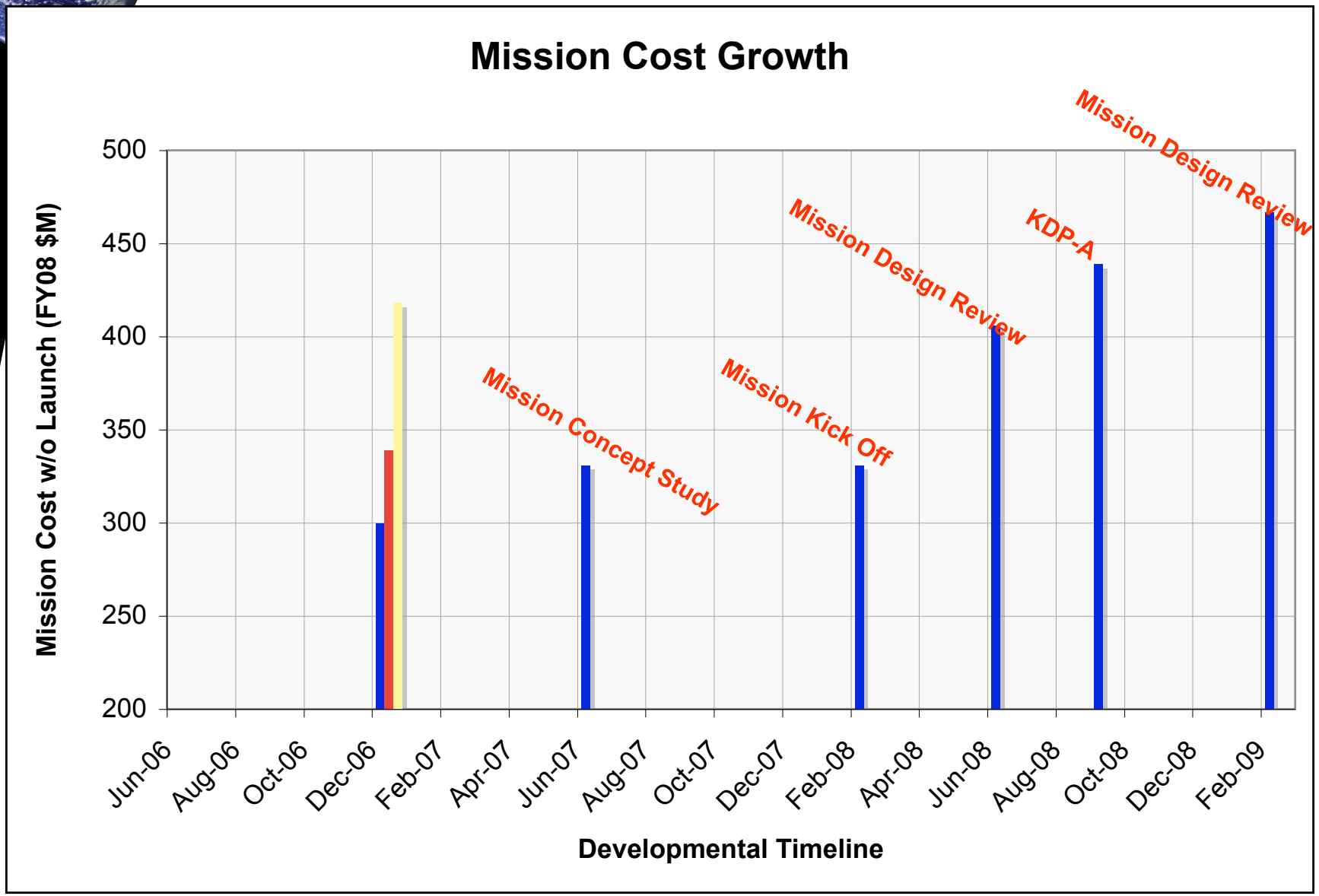
ESD estimates as of January 2007

Missions	NASA ESD Study Costs	Decadal Survey Cost*	Delta (%)	Now
CLARREO	406.3	206.4	97%	
SMAP	363.7	309.6	17%	~500
ICESat-II	523.6	309.6	69%	~650
DESDynI	712.1	722.4	-1%	
HyspIRI	396.1	309.6	28%	
ASCENDS	445.0	412.8	8%	
SWOT	533.8	464.4	15%	
GEO-CAPE	1057.1	567.6	86%	
ACE	1543.8	825.6	87%	
LIST	533.8	309.6	72%	
PATH	511.0	464.4	10%	
GRACE-II	458.7	464.4	-1%	
SCLP	496.0	516.0	-4%	
GACM	974.6	619.2	57%	
3D-WINDS	717.5	670.8	7%	
Total:	**9673.1**	**7172.4**	**35%**	

ESD estimates normalized to extent possible to match Decadal Survey assumptions (3 yr missions, no extensions, limited data analysis activities)

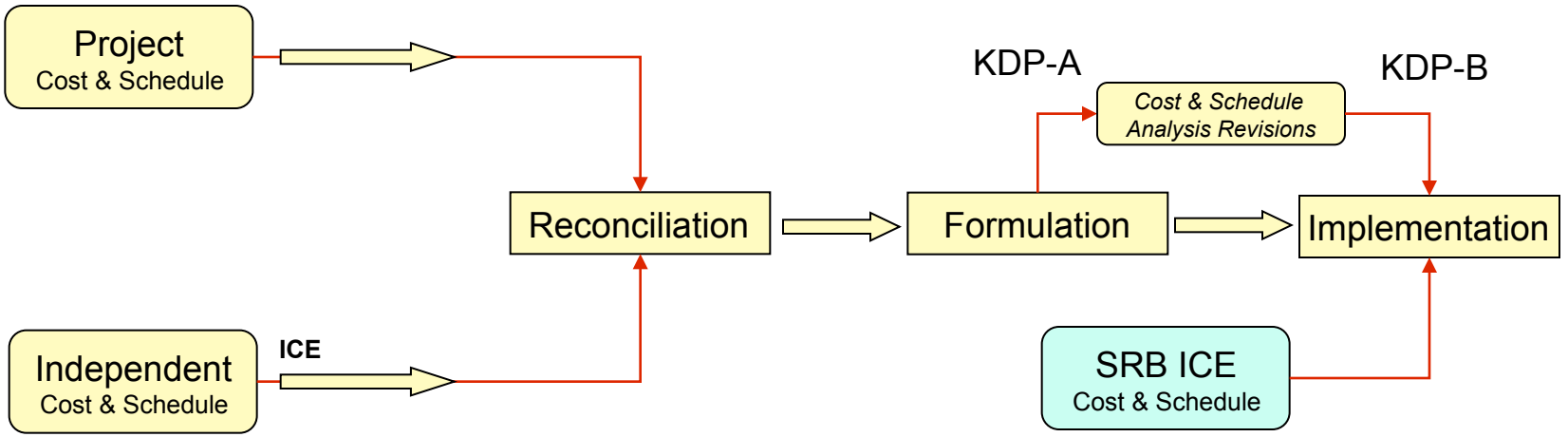
SMAP Cost History (FY08$)

SMAP Cost Assessment History



Cost & Schedule Analysis Approach

- Each mission team will develop a project level Life Cycle Cost, based on the implementing Center principles, monitored and approved by NASA HQ
- The ESD, working through the Earth Systematic Mission (ESM) program office, will conduct a parametric ICE to augment the project-generated assessment and to improve the overall Decadal Survey program planning



- The required SRB ICE and ISAwill be done as part of the standard major mission milestone gate reviews (KDP-B, -C, ...)
  - *ICE conducted to determine the 70% confidence level for LCC & LRD*
- Additional requirements are likely from the Agency for an integrated ICE/ ISA

DS Mission Team Actions

ESD & ESM PO

- Charter the independent ICE & ISA
  - *Aerospace on contract to perform this function*
  - *Requires a good conceptual baseline to conduct a good ICE*
    - SMAP is there, ICESat II with some mods
    - DESDynI there after downselect
    - CLARREO needs to clarify a baseline concept of operations
- Issue as part of updated Earth Systematic Mission Program Plan

Mission Teams

- Develop the bottoms up estimate
  - *Combination of grass roots and parametrics allowed*
  - *Look to Center principles for specific guidance*

Requirements Definition

Requirements Definition

- Phase A defined by Formulation Authorization Document (FAD)
  - *Signed at /by KDP-A*

- Phase B/C/D/E defined by Level 1 Requirements, which will include
  - *Life Cycle Cost (LCC) and Development (B/C/D) cost allocations*
  - *Performance requirements*
  - *Hardware (Phase B/C/D) and Data delivery (Phase E) requirements **and** schedule*
  - *Management implementation approach*
    - Hardware responsibilities, data system
    - Partnerships
    - Mission Classification
  - *Baseline and minimum mission*
  - *Mission Success Criteria*

- Not needed to be signed until Mission Confirmation (KDP-C), but clarity is needed much sooner to correctly define the mission scope

DS Mission Team Actions

ESD & ESM PO

- Define a standard FAD and Level 1 documents format, with defined content requirements
- Issue as part of updated Earth Systematic Mission Program Plan

Mission Teams

- Support FAD development during pre-Phase A
- Develop draft Level 1 working with PS, PE and ESMPO

Other Issues

Other Cross Mission Issues & Opportunities

- Issues
  - *Design for Orbital Debris & DCA*
  - *Authorization for long lead procurements*
  - *International/Interagency Partnership*
  - *How to integrate GPS RO into the program*

- Opportunities
  - *Applications of our missions*
    - Real time (DB) data availability and latency requirements
    - Involvement of applied sciences in requirements definition
  - *Common Technology development & qualification*
  - *Coordinated airborne campaigns*

ESM PO System Activities

Data Systems

Ground stations and systems

How do we integrate the Science across the DS missions?

Other Cross Mission Issues & Opportunities

- Set the stage at the start, we want to maximize the ability of the missions to maximize the ultimate benefit of the measurements

- Cross mission assessments
  - *Lessons learned from the EOS program (EOPM Reviews and others)*
  - *Technology readiness assessments*

- Applications of our missions
  - *Real time (DB) data availability and latency requirements*
  - *Involvement of applied sciences in requirements definition*

- Insert requirements into the standard gate reviews to address programmatic level issues
  - *Data products, compatibility with other data sets, user applicability*
  - *Product development schedules, pre- and post-launch*

Symposium Conclusions

Next Steps

- Mission Decision Plans and Processes
- Working Group Follow up

Working Group Coordination

- Would like to establish working groups from the DS mission teams to coordinate development of principles and practices for these missions

Working Group or System Study	Working Group or Study POC	SMAP	ICESat II	DESDynI	CLAR REO	SWOT	ACE	HyspIRI	ASCENDS	GEO-CAPE	Project POC(s) Requested
Systems Engineering Working Group	TBD (currently DiJoseph)										Mission Systems Engineer
Data Systems Working Group	Martha Maiden										Ground System Manager, Project Scientist, Project Manager
Common Spacecraft Study	TBD (currently Graf & Kazmi)										Project Manager, Spacecraft Manager or MSE
DPAF and co-manifest	Speciale										Project Manager, Spacecraft Manager or MSE
Real time data	SEWG										Project Scientist, Spacecraft Manager, MSE
Common Instrument procurements	Graf										Project Manager, Instrument Manager
Ground network and Downlink capabilities	TBD (Speciale & Whetsel?)										Project Manager, Ground Systems Manager, MSE
Technology readiness assessments	Graf										Project Manager, MSE, instrument manager

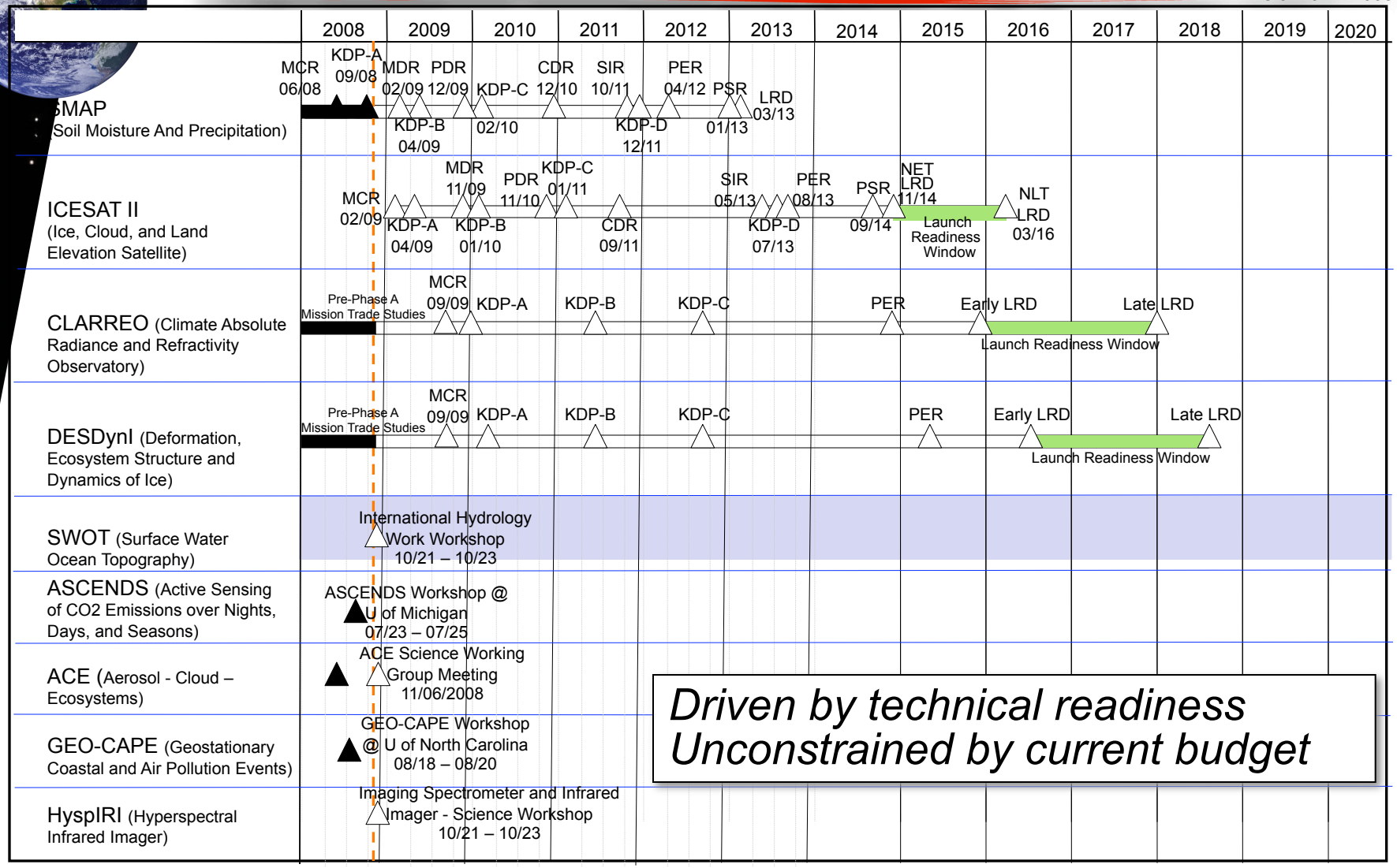
Calendar

- Budget
  - *FY09 - FY10 budget (stimulus plus FY09) should be in hand within one month*
  - *Immediate decisions for allocations into FY10 will be done in concert with ongoing PPBE process*
- Mission Decisions
  - *Teams need to refine their schedules thorugh the end of CY09 within next 4-6 weeks*
  - *Refine plans for MCR, as well as possible additional funds needed to conduct a successful MCR*
- Regroup in late April or early May with shorter agenda, focused on go forward approach for FY09 and FY10

Tier 1 & Tier 2 Notional Mission Readiness:

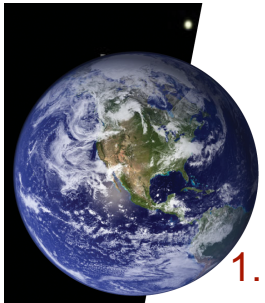
When could we be ready to fly?

As of 10/14/2008



Driven by technical readiness
Unconstrained by current budget

Milestone
Completed Milestone
Duration Bar
Progress/Status Bar
Study Phase



Decadal Survey Symposium Objectives

1. To (re)convene the multiple study groups for a joint and common assessment of their mission development progress through FY08
   - *For many in the meeting this is a follow-up to the initial mission studies kick-off (March 22) and ESD Steering Committee (May 22) meetings*
   - *For the broader group this is our first gathering*
2. To review and understand the study teams' objectives for mission development through the remainder of FY09 and into the beginning of FY10
3. To present for general education and discussion the study teams' approaches to achieving their mission development objectives
   - *This meeting is intended as an opportunity for lessons learned discussion and exchange among teams*
4. To present for consideration and discussion proposed cross cutting studies and analyses.
   - *Their importance (have we prioritized them correctly?),*
   - *Their appropriateness (are they best done at a program level?), and*
   - *Their completeness (have we missed anything both important* **and** *pressing?)*